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Variability of emergency color codes for critical events between hospitals in Riyadh

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BACKGROUND: Emergency color codes were developed to alert healthcare personnel in a hospital to critical situations. They are often developed independently by each hospital, leading to variability. This could be a source of confusion to healthcare personnel, who move frequently between hospitals and may work at multiple hospitals. This study evaluated the variability of emergency codes for different critical events in hospitals in Riyadh.

METHODS: A prospective, cross-sectional survey was carried out on a representative sample of hospitals. Twenty-four of 28 hospitals took part in the study. Semi-structured questionnaires were completed by the Quality/Safety Department of each hospital, on general hospital characteristics, emergency department characteristics, code-response mock-up, code determination, emergency codes used and code meanings.

RESULTS: Thirty-four different codes were used across hospitals. The codes used most variably were yellow (10 meanings), orange, black, green (7 meanings each), and gray (5 meanings), while the most consistently used code was 'Code Red' for 'Fire' in 75% of hospitals. Another source of variability was the use of non-color codes, representing 7.7% of total codes.

CONCLUSIONS: There is large variability in the type and meaning of emergency codes between hospitals in Riyadh City, reflecting a lack of standardization. Hospitals use color and non-color emergency codes, which could cause confusion to responders and mitigate the effectiveness and speed of response in critical events.

Emergency codes were developed to alert relevant healthcare personnel in a hospital to a critical situation, while not alarming patients and visitors. When a code is called, a pre-designated team of physicians, nurses and other personnel respond swiftly and efficiently, based on their training. When these codes are developed independently by hospitals, there is variability between hospitals. This practice has been a source of confusion at critical moments to healthcare personnel in the past.[1-5] Healthcare workers move frequently between hospitals and may work at more than one hospital,[6] resulting in an inability to remember and respond to the right code at the right time. Many healthcare workers in Saudi Arabia are expatriates who are likely to have worked in healthcare systems in other countries, as over three-quarters of physicians and nearly two-thirds of nurses in the local health care system are non-Saudi.[7] This ambiguity can have tragic consequences. A few people were killed at a medical center in California due to the wrong code being called.[8] This in fact is what prompted the Hospital Association of Southern California to push for change in this area, leading to the publication of "Health Care Facility Emergency Codes: A Guide for Code Standardization", which recommended a standard set of codes for hospitals to follow.[9,10] Many hospital associations in the United States and in other countries have since followed suit.[1,2,9,11-14] However, this standardization has not yet been implemented in Saudi Arabia, although it has previously been recommended.[15] The purpose of this study was to evaluate the emergency codes used in hospitals in Riyadh City, which to the best of our knowledge is the first study of its kind in Saudi Arabia.

METHODS

A cross-sectional survey was carried out to assess the variance in the usage of different emergency codes between hospitals in Riyadh City. A total of 24 out of 28

secondary and tertiary-care hospitals took part in the study. A semi-structured questionnaire developed after a search of relevant literature was administered by the study authors in face-to-face interviews with hospital administrators, including directors of quality/safety departments of each hospital, and the following parameters were recorded: general hospital characteristics, emergency department characteristics, code-response training, code determination, emergency codes used and the meaning of each code (Index 1-Questionnaire). The hospitals taking part in the survey were identified and selected from the Ministry of Health Statistical Yearbook,[4] as well as various online hospital directory lists to complete the list of all the secondary and tertiary-care hospitals in Riyadh City that we were aware of at the time of the study. Participation of all hospitals was voluntary and under strict confidentiality, and was approved by the Research Ethics Committee, Project # 2131-120, 19 September 2013.

All the statistical analysis of data was done using the software package SAS version 9.4 (Statistical Analysis System, SAS Institute Inc., Cary, NC, USA). Descriptive statistics for the categorical variables were summarized as frequencies and percentages and continuous variables are summarized as mean and standard deviation. Continuous variables were compared by the independent t-test or ANOVA as appropriate, while categorical variables were compared by the chi-square test and the Fisher exact test. All the comparisons were done using chi-square tests. The level of statistical significance is set at $P<.05$.

RESULTS

Of the 28 hospitals that were contacted, 24 agreed to participate in the study (response rate=85.7%), distributed as follows: 11 government hospitals (45.8%) and 13 private-sector hospitals (54.2%). The number of participating teaching hospitals was 10 (41.7%), all of which were governmental. Comparison of the mean number of emergency codes between the government sector (mean=8.3, SD=1.8) and the private sector (mean=9.2 SD=1.6) found no significant difference between the two sectors ($P=.123$).

Events were coded for by a color, a code name or a number. Although the greatest number of codes an individual hospital had was 13, there were 34 different codes used across all hospitals. There was also great variability in the meanings that each code had, with the greatest number of different usages for yellow (9 meanings), orange, black, green (7 meanings each), and gray (5 meanings), while the most consistently used code was 'Code Red=Fire' in 75% of hospitals (**Table 1**). There were also several non-color emergency codes used by the hospitals, although they are used much less than color codes, representing only 7.7% of total emergency codes in all hospitals in Riyadh City. Some were plain-language codes, e.g. 'Full External Disaster' and 'All Clear' (**Table 2**).

Comparison between the government and private sectors in the number of hospitals that have a code for the most critical events (**Table 3**) found that a significantly greater number of private hospitals coded for 'Fire' than government hospitals ($P=.044$), but there was no significant difference for other events.

DISCUSSION

There is large variability in the types and meanings of emergency codes, and in the definition of critical events between hospitals in Riyadh City, reflecting a lack of standardization (**Table 1**). Over 78% of the color codes had at least two different meanings, and the median number of meanings a color code could have was 3.5. This could cause confusion to responders and serious consequences for anyone involved. This variability may also mitigate the effectiveness and speed of response in critical events.[7,16] Besides the lack of uniformity in emergency codes, critical events are often defined differently between hospitals, e.g. 'Fire' is included in 'Internal Disaster' in some hospitals, whereas in others each has its own code. Similarly, 'Oxygen Outage' is given a separate code sometimes, or included in 'Utility Failure' at others. This creates a second source of ambiguity, and increases the potential of announcing or responding to a wrong code. A third source of variability relates to the use of non-color codes such as 'Code 99' or 'Code Adam' (**Table 2**) as these codes may be even more difficult to recall at the crucial moment. A fourth area of variance between emergency codes in Riyadh hospitals is in what critical events are included in emergency codes. Some hospitals have codes for unique events such as 'Sandstorm', 'Death' or 'Emergency Department Overcrowding' not found in the majority of other hospitals. Having codes for unique events may be required by specific hospitals, but generally emergency codes should be standardized across all hospitals. On the other hand, some of these unique codes e.g. 'Sandstorm' should be included as an emergency code, so that a timely 'bad weather' warning can be given to staff for contingency plans.

The lack of standardization of emergency codes creates the risk of misunderstanding them, and this is their main disadvantage. During our data collection, incidents of staff activating a wrong or unnecessary color code and/or delayed response were reported by

Table 1. Variability between Emergency Codes in Riyadh hospitals.

Emergency Color Code	Meaning	N (out of 24)	%
Red	Fire	18	75
	Internal disaster	6	25
Blue	Cardiac arrest/Respiratory failure	16	66
	Adult medical emergency	4	16.7
	Pediatric medical emergency	1	4.2
Green	Clear code	3	12.5
	Evacuation	2	8.3
	ED overcrowding	2	8.3
	Pediatric medical emergency	2	8.3
	Adult medical emergency	1	4.2
	Hazardous/chemical spill	1	4.2
	Cardiac arrest-child	1	4.2
Pink	Infant/child abduction	18	75
Yellow	Sandstorm/Inclement weather	4	16.7
	External disaster	4	16.7
	Oxygen outage	3	12.5
	Utility failure	2	8.3
	Hazardous/chemical spill	2	8.3
	Internal disaster	1	4.2
	Bomb threat	1	4.2
	Polytrauma	1	4.2
	Road traffic accident in Emergency Room	1	4.2
Black	Bomb threat	9	37.5
	External disaster	7	29.2
	Internal disaster	3	12.5
	Combative person/security needed	1	4.2
	Polytrauma	1	4.2
	Massive casualties	1	4.2
	Death	1	4.2
Orange	Hazardous/chemical spill	10	41.6
	Clear code	3	12.5
	External disaster	2	8.3
	Bomb threat	2	8.3
	Oxygen outage	1	4.2
	Internal disaster	1	4.2
	Adult medical emergency	1	4.2

Emergency Color Code	Meaning	N (out of 24)	%
Amber	External disaster	2	8
Brown	Hazardous/chemical spill	2	8.3
	Combative person/security needed	2	8.3
	Explosion	1	4.2
	Sandstorm/Inclement weather	1	4.2
Grey	Utility failure	4	16.7
	Combative person/security needed	3	12.5
	Hazardous/chemical spill	1	4.2
	Bomb threat	1	4.2
	Internal disaster	1	4.2
Silver	Combative person/security needed	2	8.3
White	Bomb threat	7	2.92
	Combative person/security needed	6	25
	Evacuation	2	8.3
	Clear code	1	4.2
Purple	Combative person/security needed	2	8.3
	Missing child/adult	1	4.2
Violet	Combative person/security needed	2	8.3
	Oxygen outage	1	4.2

N=The number of Hospitals with that code.

two governmental hospitals. Internationally, similar incidents have prompted a movement towards adopting plain language emergency codes, especially for events that could have dire consequences for patients and visitors, such as an 'Active shooter' or 'Hostage' situation within the institution.[10,17,18] Use of plain language in a healthcare setting has been demonstrated to improve patient safety outcomes.[19] Therefore, codes that are often ambiguous have been replaced by descriptive codes e.g. Codes Silver/Gray/Violet may be replaced by 'Active Shooter' or 'Armed Violent Intruder'. If such codes are developed in the Middle East, they should be announced in both English and Arabic to ensure universal understanding.

Although this study did not evaluate actual staff understanding of emergency codes, many of the hospitals surveyed did not carry out regular drills for all the emergency codes. We believe, therefore, that certain measures like staff carrying codes along with their ID, regular code drills, and explaining the rationale behind each color will help staff remember them. For example, blue is the color patients show in cardiorespiratory arrest due to hypercapnia, orange is usually the color used to label hazardous material, whereas silver is often the color of guns.

Despite the benefits of standardizing codes, there are significant challenges to be overcome. Healthcare in Saudi Arabia is delivered under different sectors, including the Ministry of Health, other governmental sectors and the private sector. This makes the standardization process between individual hospitals much more complex. We therefore recommend that the higher authorities and regulatory bodies bring together local experts to develop standard emergency codes for hospitals in Saudi Arabia. An example of a clear, easy set of codes that could be used as a framework is the State of Ohio, USA, Emergency Codes[20] (Index 1). To evaluate the success of standardization efforts and institutional

Table 2. Variability between non-color emergency codes in Riyadh hospitals.

Emergency Code	Meaning	N (out of 24)	%
Code 99	Cardiac arrest/Respiratory failure	1	4.2
Code 99 Pedia	Pediatric medical emergency	1	4.2
Code 99 RTA	Road Traffic Accident in ER	1	4.2
Code 20	Adult/medical emergency	1	4.2
Code 40	Pediatric medical emergency	1	4.2
Adam	Missing Child/Adult	1	4.2
Exit	Infant/child abduction	1	4.2
Lockdown	Infant/child abduction	1	4.2
Triage internal	Internal disaster	1	4.2
Triage external	External disaster	1	4.2
Code 0000	External disaster	1	4.2
Full external disaster	External disaster	1	4.2
Code trauma	Massive Casualties	1	4.2
Mr Strong	Combative person/security needed	1	4.2
All clear	Clear code	1	4.2

Table 3. Comparison of critical event codes between government hospitals and private sector.

Event	Government N (out of 11)	Private N (out of 13)	*P* value
Fire	8	13	.044
Hostage situation	7	9	.772
Missing adult	1	2	.642
Infant abduction	9	12	.439
Bomb threat	9	11	.855
Severe weather	1	4	.193
Hazardous spill	7	10	.476
Disaster	10	10	.360
Violent patient	10	13	.267
Adult medical emergency	10	12	.902
Pediatric medical emergency	5	6	.973

N=Number of hospitals that have a code for that event; *P* values from chi-square test. For variable 'Fire': chi-square test statistic=4.052, df=1.

compliance, a much larger follow-up study to include various regions and provinces in Saudi Arabia can be conducted.

Limitations of this study are that it was only conducted in Riyadh City, and that the actual training and competence of hospital staff in the use of emergency codes was not recorded. It did not collect adverse events data due to the wrongful utilization of emergency codes, and did not ascertain how each hospital developed its codes. Since data collection was completed, new hospitals have been built, so not all hospitals in Riyadh City have been included in this study.

Hospitals use different color and non-color emergency codes. The most consistently used code was 'Code Red' for 'Fire' and 'Code Blue' for 'Cardiorespiratory Arrest' while the codes used with the most variability were 'Code Yellow', 'Code Orange' 'Code Black' and 'Code Green'. Clearly there is a large variability in the type and meaning of emergency codes between hospitals in Riyadh City, and therefore there is an urgent need for standardization of emergency codes in Riyadh City and Saudi Arabia.

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